FO OUTLOOK
NASA AMES RESEARCH CENTER

Information for the NASA Ames Wind Tunnel Test Community May 2003

First launch set for May 30

NASA CENTERS TEST PARACHUTES FOR MARS ROVERS

By Catalina Ortiz

Code FO is playing an important role in the next mission to Mars, a project that will search for signs of water where conditions once may have been favorable to life. A test in the 80-by-120-Foot Wind Tunnel helped NASA's Jet Propulsion Laboratory select a parachute design for the two Mars Exploration Rover (MER) spacecraft being launched in May and June.

Members of the MER parachute test team inspect an inflated chute in the 80-by-120-Foot Wind Tunnel

Engineers and technicians tested a dozen different parachutes, firing some out of mortars 110 feet downstream in the test section while the wind tunnel was running. The giant wind tunnel simulated the conditions the probes will encounter as their parachutes slow their descent through the thin martian atmosphere.

The MER parachute test, conducted from September to January, involved three NASA centers: the Jet Propulsion Laboratory (JPL), Langley Research Center, and Ames. It demonstrated the continuing importance of Ames' wind tunnels to U.S. space missions and illustrated the ability of Ames' engineers and technicians to plan and carry out complicated tests as a launch window draws near.

The test also provided JPL with an alternative to testing parachutes by dropping them out of helicopters with payloads attached. Using the 80-by-120-Foot Wind Tunnel allowed JPL to conduct full-scale tests in a controlled environment and obtain a large amount of test data quickly. JPL gave Code FO a high rating for the test.

"A sincere thank you goes out to the team from Ames for doing an excellent job meeting this very ambitious schedule and delivering a well-staffed facility and a perfectly run test," says the JPL's Dr. Adam D. Steltzner, principal investigator of the MER test.

NASA plans to launch the first of two identical MER probes on May 30 and the second on June 26. Both will reach Mars in January 2004, landing in different areas where liquid water may once have been on the planet's surface.

When each 400-pound MER, encased in a lander, enters the martian atmosphere, a parachute about 28 feet in diameter will slow its descent. Airbags will inflate and cushion the landing, allowing the spacecraft to bounce on the surface. Once the spacecraft comes to rest, the airbags will deflate and retract. The lander will then right itself and open like the petals of a flower, allowing the six-wheeled, solar-powered rover inside to begin its exploration.

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NASA CENTERS TEST MARS PARACHUTES

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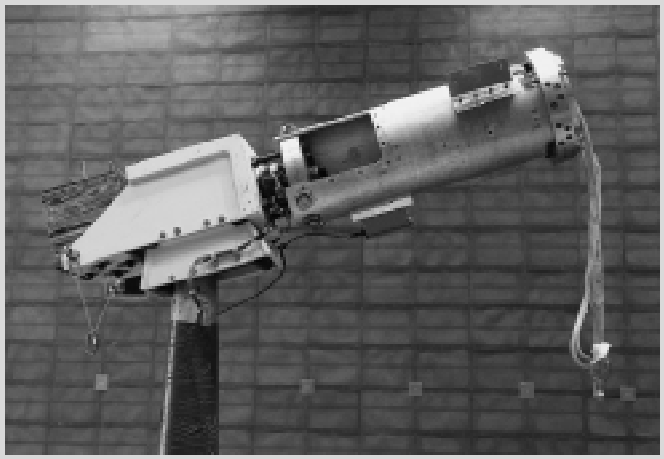
Each MER will be able to travel up to about 110 yards each martian day – the same distance that the 1997 Mars Pathfinder rover covered in three months. Each rover will carry a panoramic camera and an array of scientific instruments, which will test martian soil and rock for evidence of water. Each rover is expected to operate for at least 90 days.

The parachute test at Ames' 80-by-120-Foot Wind Tunnel was conducted in several phases. The first demonstrated that JPL could get the data it wanted by testing the chute in a wind tunnel, and the second tested different candidate parachutes provided by Pioneer Aerospace Corp. so that engineers could choose the best design. The third phase tested the chosen parachute to make sure that it met structural standards for the MER mission.



The MER parachute attachment mechanism

Each phase included static runs and dynamic runs, both conducted at wind speeds of 90-100 mph. During a static run, the test team opened a parachute on the test-section floor, then turned on the wind tunnel and allowed the chute to inflate. Static runs allowed the team to study the parachute's performance when open.

During a dynamic run, with the wind tunnel already set at the desired wind speed, a parachute was fired out of a mortar 40 feet above the test-section floor. The chute, fired at a speed of about 150 feet per second, flew down the test section and opened, completing an inflation cycle. The wind speed was then reduced and team members were able to enter the test section to examine the parachute as it hovered above the floor.

Artist's conception of the Mars Exploration Rover on the martian surface. Image from www.jpl.nasa.gov.

Dynamic runs determined whether a parachute could meet the Mars mission's structural requirements: sustain an opening drag load of at least 24,200 pounds, 25 percent greater than the expected load on Mars. A total of 19 inflations – static and dynamic – occurred over the course of the test.

Designing a parachute attachment mechanism that could handle the mortar reaction and parachute opening loads – while operating safely – was one of the main challenges of the test. Another was developing the instrumentation. The test team attached the mortar to a ball-and-socket pivot mechanism and fitted the attachment with a single-axis load cell to measure the drag on the parachute.

A Kevlar® break-cord kept the mortar 10 degrees above horizontal at the time of firing. The MER test also measured test-section dynamic pressures and wall static pressures and used six video cameras to record each run from different angles.

Although the MER spacecraft will travel at supersonic speeds as they enter Mars' atmosphere, the low-speed 80-by-120-foot Wind Tunnel was able to simulate martian entry conditions. That's because the red planet's atmosphere is only 1/140th as dense as the Earth's; 90 mph in the 80-by-120-foot Wind Tunnel is equivalent to supersonic speeds on Mars.

Code FO was able to draw on its previous experience with parachutes – including the Space Shuttle Orbiter drag chute test in 1993 – and explosives – including a mid-1980s parachute-ejection test of the F-11 bomber. Code FO's track record and its unique facilities made Ames the ideal place for the MER test – and the ideal place for similar projects to come.

"The JPL and Pioneer Aerospace MER project personnel assured us that future planetary parachute design teams will plan tests in the 80-by-120," said test manager Pete Zell.

FO CONNECTION TO HYBRID ROCKET FUEL PROJECT

By Catalina Ortiz

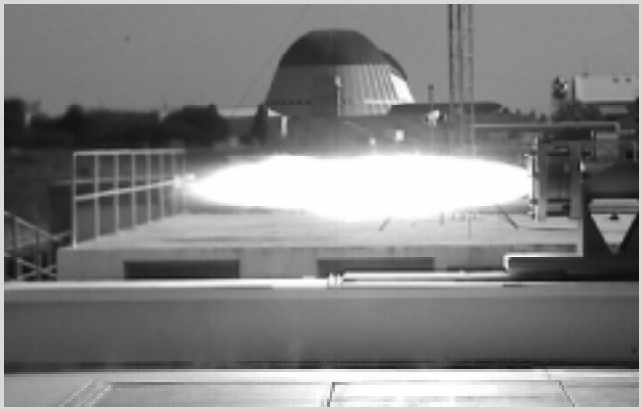
One of Code FO's engineers is involved in research that could make space travel cheaper and safer. Rusty Hunt designed the control systems for an Ames-Stanford University project that studies the potential of paraffin-based hybrid rocket fuel.

Rusty, chief engineer and facility manager for the National Full-Scale Aerodynamic Complex, got involved in the project through an aerospace-propulsion class he took at Stanford.

"This really could revolutionize the space business if it turns out as well as it promises," he says.

Rockets that launch spacecraft are powered by a combination of fuel and oxidizer that are mixed together into a solid. Hybrid rockets initially keep solid fuel and liquid oxidizer separate, then gasify the liquid oxidizer and combine it with the solid fuel in a combustion chamber.

Solid hybrid rocket fuels are safer to handle, and therefore cheaper, than conventional solid fuels. Hybrid-fuel rockets also can shut down and restart, unlike solid-fuel rockets, which keep firing until all their fuel is burned. However, hybrid fuels tend not to have a high enough burn rate for launching spacecraft.



Test firing of a hybrid rocket using paraffin-based fuel at Ames' Hybrid Combustion Facility

But experiments at Stanford showed that paraffin-based fuel, similar to the wax used in candles, burns three times faster – producing more thrust – than other hybrid fuels. In tests at Ames, researchers found the same high burn rates when they scaled up their experiments. As an added bonus, paraffin burns cleanly, producing carbon dioxide and water vapor.

The experiments at Ames are being conducted at the Hybrid Combustion Facility (HCF), which was built at the Outdoor Aerodynamic Research Facility. Researchers have conducted 41 firings at the HCF since September 2001, testing 7.5-inch diameter paraffin cylinders weighing up to 60 pounds that produce up to 3,500 foot-pounds of thrust.

Project team members at Ames' Hybrid Combustion Facility. Code FO's Rusty Hunt is at top center.

Rusty designed the control systems that regulate the HCF's oxygen pumping, oxygen delivery, and fuel ignition. The task was a challenging one because each test run lasts no more than 10 seconds. He also developed the graphical-user interface for the control system. Although he did most of his work in the year leading up to the first firing, Rusty remains responsible for the control system.

Code APS' Gregory Zilliac is chief test engineer for the Ames-Stanford project. Shane DeZilwa and Paul Soderman, both of Code APS, also are involved in the test. The Stanford researchers are Arif Karabeyoglu, who developed concept of paraffin-based hybrid fuel as a graduate student, and Brian Cantwell, chair of Stanford's Department of Aeronautics and Astronautics.

The next phase of the project will focus on the physics of the combustion process. Until now, tests have used paraffin fuel in the form of a cylinder with a hole running down its center; the oxidizer has been injected into the hole. Researchers now plan to put a slab of paraffin fuel inside a new combustion chamber

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GETTING A NEW CHARGE OUT OF GETTING AROUND

Moving between Code FO's facilities is a little easier – and more fun – thanks to the acquisition of two new electric vehicles. The two carts, nicknamed Mustard and Ketchup, carry people and small amounts of equipment quickly between wind tunnel test sections and division offices.

Each cart can carry four people at a top speed of 25 mph. The zero-emission vehicles are charged by plugging in to a normal 110-volt electric outlet.

The vehicles are identical except that Ketchup has red trim on its white plastic body and Mustard has yellow trim.

Mustard and Ketchup, made by DaimlerChrysler's Global Electric Motors subsidiary, replace two older electric carts that did not work as well. The new carts are popular with the division's staff and are easy to drive, says FOI Chief Herb Finger, who named them.

The vehicles are kept in the 11-by-11-Foot Transonic Wind Tunnel's storage barn. Anyone in the division can borrow one by getting the key from Herb and reading the simple instructions.

The most important things to know are where the forward and reverse button is and how to turn off the emergency brake. "And definitely wear seat belts. They can throw you; they can take a corner pretty quickly," Herb says.

Mustard and Ketchup operate in two modes: standard, for paved roads; and turf. The carts require eight to 10 hours to recharge and are kept plugged in when not in use so that they will be fully charged when needed. But, unlike their predecessors, the carts need not have their batteries fully drained before recharging.

Michelle Foster drives Ketchup back from an errand at the NFAC

Under National Highway Traffic Safety guidelines, the GEM carts are Low Speed/Neighborhood Electric Vehicles. They are used on college and industrial campuses, national parks, military bases, and golf courses. Mustard and Ketchup are two of 20 GEM vehicles recently purchased by Ames Research Center.

Each cart has a small, box-like trunk capable of carrying passenger's personal belongings or small amounts of equipment. The division is considering buying a couple of accessories: canvas doors and a flat deck that can be swapped for the small trunk. Meanwhile, Herb is keeping his eye out for extras that the manufacturer doesn't offer: Heinz®Tomato Ketchup and French's® Mustard stickers.

CODE FO AT THE AIAA AEROSPACE SCIENCES MEETING

Phil Stich and Pete Zell at Code FO's booth in Reno

By Phil Stich

For the second straight year, the Wind Tunnel Operations Division sponsored a booth at the January AIAA Aerospace Sciences meeting in Reno. All of our usual competitors and colleagues (AEDC, Veridian, NASA Langley, NASA Glenn) were there, but as you might have guessed, our display was clearly superior (see photo).

Our participation in this conference/exhibit is important because it helps us communicate to the aerospace community that we have very capable facilities to support their system-development requirements. Frank Kmak, Norbert Ulbrich, Pete Zell, and I staffed the booth over the three-day exhibit schedule, talking to potential customers and answering questions. This year we handed out Code FO mousepads, patches, calendars, and cork coasters to the throngs of interested conference attendees.

ERIC MATTOX AWARDED CERTIFICATE OF EXCELLENCE

Eric Mattox receives his certificate from Nancy Bingham

Eric Mattox of Sverdrup has been awarded a Contractor Certificate of Excellence for his behind-the-scenes, yet crucial, contribution to Code FO's success. As the division's buyer, Eric performs multiple roles. In addition to managing all shipping and receiving, he also maintains the radio inventory and the Unitary tool crib. He performs all these tasks with enthusiasm and professionalism, striving to meet everyone's needs despite many urgent priorities.

On several occasions in the past year, Eric helped expedite key part orders for the Large Rotor Test Apparatus (LRTA) program. Within 24 hours, Eric arranged the certification of equipment to lift the 70,000-pound LRTA model from the 80-by-120-Foot Wind Tunnel – a service that usually requires two weeks of lead time. He also conducted Code FO's annual ladder safety survey without any impact on his other work. Eric's attitude, work ethic, and willingness to take on any task are a model for the entire division.

CODE FO EMPLOYEES OF THE MONTH

Abraham Seyoum – Underground Cable Repair

Electrical engineer Abraham Seyoum was cited for his outstanding performance in specifying the scope of work, coordinating and expediting the repair of two underground high-power cables. The two 13.8-kilovolt cables supplied electricity to the N250 HPADS compressor and N234 vacuum pumps, facilities vital to the Arcjet and wind tunnels. An inspection revealed that the cables had shorted and burned. The repair had to be performed quickly because of a test scheduled for the Arcjet. Abraham oversaw the entire project, including writing a procedure, setting a schedule, overseeing the contractor, addressing safety concerns, coordinating with JFP electricians and FO safety engineers and obtaining permits. Despite budget and technical constraints, the entire job was completed within two days, allowing the test in the Arcjet to proceed.

Abraham Seyoum

Jim Strong

Jim Strong – Global Hawk Test

Jim Strong was cited for providing outstanding test management for the Global Hawk two-dimensional wing test throughout the model design, model fabrication, and test phases. The test, conducted in the 11-by-11-Foot Transonic Wind Tunnel, studied two 2-D airfoils for the Global Hawk unmanned surveillance aircraft. It provided an airfoil lift and performance database to help engineers compare near flight Reynolds number data between the current airfoil design and a new one. After the project was accepted, Ames had only two months to have everything ready to test. Jim's dedication, attention to detail, and excellent coordination skills throughout all phases of this challenging test were the keys to the success of this critical program.

FO CONNECTION TO HYBRID ROCKET FUEL PROJECT

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with view windows and shoot the oxidizer across the surface of the paraffin. They plan to study the diffusion region, the area where paraffin is vaporized.

The ultimate goal of hybrid fuel research is to power rockets that launch space vehicles. The Stanford-Ames group is starting to work on another, related project that involves combining hybrid-fuel rockets with an oblique-wing vehicle. Researchers have done computer simulation of such a combination and are now building a model that they hope to test in Nevada.

CODE FO 2002 PEER AWARDS

Art Silva

Art Silva – Operational Achievement

Facility instrumentation engineer Art Silva has constantly maintained and improved instrumentation systems at the NFAC. His unwavering dedication to this task continues despite budget and staffing constraints. Art's attention to detail and ability to respond swiftly to challenges make him a key member of every NFAC test team. His contributions to the Mars Exploration Rover (MER) test were crucial in meeting the customer's instrumentation requirements. Art's efforts to keep the external balance system operational are an excellent example of his creative engineering skills. His actions allow the NFAC to remain a viable test facility with a diverse set of test capabilities. Art's constant eye for instrumentation system improvements helps keep the NFAC as efficient and economical as possible. His dedication to the NFAC instrumentation systems minimizes facility downtime and contributes to the division's continued good customer quality ratings.

Harold Reimer – Customer Service Achievement

Harold Reimer

Stress analysis engineer Harold Reimer performs the difficult and the time-consuming task of compiling and reviewing test article stress reports for the Wind Tunnel Operations Division. His engineering capabilities and wind tunnel testing experience provide Harold the knowledge and insights necessary to assist test engineers and customers in model and support system design. Over the years, the roles and responsibilities of the division's stress engineer have grown dramatically. Harold's contributions were critical to the success of the design efforts associated with the AIM 9X missile test, the F-16 Pod test, the Orbital Science missile test, the Navy Antenna test, the C-5 semispan test and the Global Hawk test. With Harold's diligence, the division test schedule has been met, along with assurances that test articles have the prescribed margins of safety.

Pat Crooks – Leadership Achievement

As resources manager, Pat Crooks has provided invaluable support to the Wind Tunnel Operations Division through her tireless efforts to manage its financial affairs. With her steady hand on the budget rudder, she has led the division through some difficult times. She is the division lead for the implementation of the NASA-wide Integrated Financial Management Program (IFMP). Pat's calm demeanor and excellent organizational skills provide the division with a stabilizing influence. Her professionalism is apparent to customers, center financial leaders, and division staff members. Leadership of the division's financial affairs is rarely recognized unless something goes wrong. Pat has provided consistent leadership and keeps division management aware of any financial changes that appear on the horizon. Her attention to detail prevents problems from happening, a goal of every good project manager. Her mentoring skills and patience are obvious as she works on a daily basis with a diverse staff with a wide array of financial concerns and questions.

AIAA, STAI HONORS FOR MIKE GEORGE

Wind Tunnel Operations Division Chief Mike George, left, has been elected associate fellow of the American Institute of Aeronautics and Astronautics. He and other new associate fellows were recognized in January at the AIAA Aerospace Sciences meeting in Reno. To be eligible as an associate fellow, a candidate must be a senior member of the AIAA and have at least 12 years of professional experience. A candidate also must have accomplished or have been in charge of important scientific or engineering work or otherwise have made outstanding contributions to aeronautics or astronautics. Also, in April Mike was elected to a one-year term on the Executive Committee of the Supersonic Tunnel Association International (STAI). He will serve as a Member-at-Large on the Committee.